

CONTENTS

1	Introduction.....	2
2	Overarching Goal of this Design standard and Construction Specification	2
3	Scope of this Guide.....	2
4	Overview of Trail and Track Design Standards	3
5	Trail Grading & User Groups.....	4
6	Comparison with NZCT/DOC Grading System	4
7	Detailed Trail Grade Specifications.....	5
8	Cycle Trail Design Considerations.....	7
8.1	Step 1: Identify the User Group & Required Trail Grade	7
8.2	Step 2: Design Alignment.....	7
8.3	Desire Line	7
8.4	Hair pins or Switchbacks.....	7
8.5	Curves, hills and Cross-fall	8
8.6	Geotechnical Assessment of Trails	8
8.7	Design Approval by QLDC	8
8.8	Trail Construction & Completion	8
8.9	The Defects Period.....	9
9	Trail Construction Specification – Grade 2	10
10	Trail Construction – Typical Cross Sections & Details.....	10
11	References.....	10
	APPENDIX 1 – CONSTRUCTION SPECIFICATIONS	11
	APPENDIX 2 – TYPICAL DESIGN DETAILS	25

1 INTRODUCTION

The Queenstown Lakes District Council administers over 180km of cycle trails and tracks. These trails and tracks are a valuable asset to the Lakes District and the purpose of this standard is to ensure greater consistency and quality in the development of all new trails. For simplicity, trails (as called in Wakatipu) and tracks (as called in Wanaka) will collectively be referred to as trails by this document.

The development of a cycle trail design standard is being driven by the increasing development of cycle trails in the Queenstown Lakes District and in particular trails developed as part of private land development projects as well as those created by volunteer organisations.

The Council has recently taken over ownership of numerous sections of cycle trail in both Wanaka and Queenstown and many of these have been built with significant design and construction defects which results in the ratepayer funding realignment and repair works. Council is looking to minimise this cost and ensure better quality trails are developed in the future to be fit for purpose.

This standard is intended to guide cycle trail designers and developers to achieve consistently high standards of cycle trail best suited to meet long term community needs (network connections and latent demand) and minimise ongoing maintenance costs to Council, as the trail owner.

The guide has been developed to closely mirror the New Zealand Cycle Trail (NZCT) “Cycle Trail Design Guide”, 2010 with minor changes to take into account changes in design and construction that have arisen during the course of the National Cycle Trail projects. The changes are in maximum gradients, surface finish and additional detail on trail geometry that was not dealt with by this previous standard.

The NZCT guide implemented and widely publicised the 1-6 trail grading system used by the mountain biking community. In terms of trails developed within the QLDC, these will be graded 1-3 with tracks graded 4-6 being purpose built mountain bike tracks and not cycle trails. Development of mountain bike tracks is outside of the scope of this standard.

Additionally, the Department of Conservation (DOC) also have track design guides. These mainly relate to walking track construction and are available on the DOC website. DOC has adopted the NZCT grading system of rating trails as 1-6.

2 OVERARCHING GOAL OF THIS DESIGN STANDARD AND CONSTRUCTION SPECIFICATION

To guide land developers and trail designers to achieve a high quality cycle trail specifically designed and built to cater to the needs of the community(s) it connects and serves and that minimises future maintenance costs to Council.

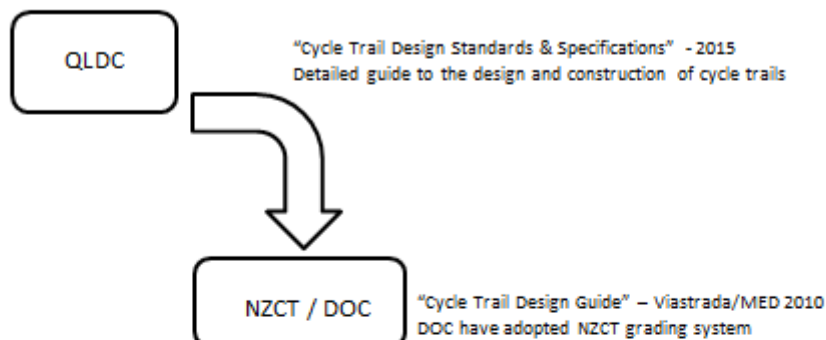
3 SCOPE OF THIS GUIDE

The design and construction of Grade 1-3 cycle trails. The design and construction of ‘mountain bike’ tracks (Grades 4-6) is very well covered by the IMBA “Guide to Building Sweet Singletrack” 2004 design guide (Refer references section). DOC’s track design guides are best suited for the design of walking tracks only.

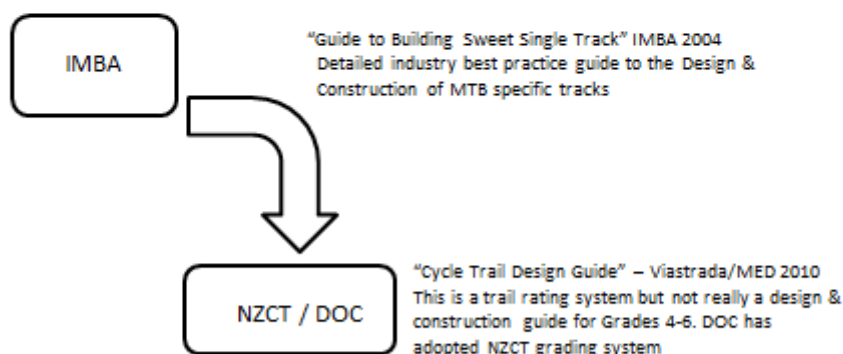
The design and construction of trails suited to horses has not been considered as part of this guide.

4 OVERVIEW OF TRAIL AND TRACK DESIGN STANDARDS

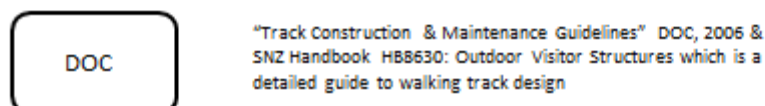
GRADE 1, 2 & 3 CYCLETRAILS



GRADE 4, 5 & 6 MTB TRACKS



WALKING TRACKS



5 TRAIL GRADING & USER GROUPS

The New Zealand Cycle Trail Project (NZCT) commissioned a design guide in 2010 as part of the nationwide cycle trail development project. Completed by Viastrada this guide is the best starting point in the identification of a cycle trail grading system. (See Cycle Trail Design Guide 2010 – Ministry for Economic Development)¹.

Over the intervening 5 years we have refined this system and present the refined grading technical specifications as follows:



- I. Grade 1 – Easiest; gentle grades up to 2 degrees (1: 28) with short sections <100m up to 3 degrees, wide (2.5m+) and smooth trail ideal for all user groups. No fall hazards. These are ideal for connecting communities and where families and novice cyclists are likely to be present.



- II. Grade 2 – Easy; Some gentle hills up to a maximum of 4 degrees (1: 14), wide (2-2.5m) with some short (<50m) narrow sections of minimum width 1.5m, smooth surface with critical fall hazards within 2m of track edge fully protected. These are ideal for connecting communities and where families and novice cyclists are likely to be present but where Grade 1 gradients cannot be achieved due to terrain constraints.



- III. Grade 3 – Intermediate; gradients 0-4 degrees typically, more regular hills acceptable up to a maximum 6 degrees (1: 10) where unavoidable terrain, width 1.2-1.5m and extended narrower sections of minimum width 1.2m. Critical fall hazards at track edge protected only. This is essentially an easy mountain bike track.

The majority of trails within the QLDC network are classed as Grade 1-2 with a few being Grade 3. Table 1 gives a breakdown of the various grades for existing local trails.

In order to provide the greatest accessibility to any new trails, every trail should be designed to meet Grade 1 or 2. Grade 3 should only be considered where the users are predominantly not commuters, families or novice cyclists and the trail is not forming part of a connective network to link communities or part thereof. In other words, not a critical linkage to the cycling network.

6 COMPARISON WITH NZCT/DOC GRADING SYSTEM

DOC has adopted the now widely used Kennet Brothers/NZCT trail grading system using numbers 1 to 6 to classify trails according to trail difficulty. Below is a brief overview of the difference to this standard:

- > NZCT Grade 1 – Same except grades not allowed to be steep if ridden in one direction only.
- > NZCT Grade 2 – Allows maximum grade of 6 degrees (leading developers to use this as a default grade), allows surface roughness like roots and rocks (not suited to rider group), topcourse aggregate of 30mm particle size (too coarse for good surface finish – Max 20mm)
- > NZCT Grade 3 – Allows grades up to 5 degrees (too steep, likely to cause rutting) and maximum grades of 9 degrees (too steep for most riders, ruts badly)

In summary, this new standard responds to the desire of many trail developers to seek the shortest and steepest line for their trails. Setting lower grade limits and including trail geometry and cross fall details in the design specification is aimed at reducing the most common trail defects noted in this region.

¹ <http://www.nzcycletrail.com/about/resources>

7 DETAILED TRAIL GRADE SPECIFICATIONS

The minimum specifications for each trail grade can be expanded as follows:

Grade 1



- > A minimum width of 2.5m allowing for side by side riding. This makes passing and overtaking easy, and provides sufficient width for novice riders to feel secure. The minimum width may be reduced to protect historic features, or for environmental or visual amenity reasons. Width also caters for 4wd vehicle access for maintenance purposes.
- > Maximum prolonged gradient of 2 degrees (1:28). Maximum gradient of 4 degrees (1: 14)
- > Maximum out-slope cross fall of 3% for straight sections of track.
- > Corners shall have a minimum inner radius of 6.0m and in-slope gradient or cross-fall of 6-8% except hair pins which must not exceed Typical Detail Sheet R4030_E3_3 of 2.5m
- > Minimum structure width of 2.0m clear. Clear means between the closest parts of the barriers.
- > A clearly sign posted, well defined trail from beginning to end so visitors can easily find their way in both directions and during inclement weather
- > A compacted, well bound smooth riding surface with suitable camber to provide a pleasurable and easy riding experience. Riders should never feel they are going to slide off the trail. Minimum compacted aggregate depth of 75mm
- > All water courses to be culverted or bridged
- > All areas of fall hazard (exposure) shall be protected with barriers that meet the building code.
- > No stiles are to be used. All fences are to be crossed using cattle stops/bollards
- > Sight lines – a minimum of 15m clear sight distance is to be achieved around all corners

Grade 2



- > A minimum width of 2.0m but generally 2.5m wide allowing for side by side riding. This makes passing and overtaking easy, and provides sufficient width for novice riders to feel secure. The minimum width may be reduced to protect historic features, or for environmental or visual amenity reasons. Width also caters for 4wd vehicle access for maintenance purposes.
- > Maximum prolonged gradient of 4 degrees (1:14) but where length >100m it must be broken with flat recovery sections 10m long minimum at 50-75m spacing's. Maximum gradient of 6 degrees (1: 10) for no more than 30m without a flatter recovery section of equal or greater length
- > Maximum out-slope cross fall of 3% for straight sections of track.
- > Corners shall have a minimum inner radius of 6.0m and in-slope gradient or cross-fall of minimum 6-8% (to be suited to the trail geometry to ensure slip free riding at design speed) except hair pins which must not exceed Typical Detail Sheet R4030_E3_3 of 2.0m
- > Minimum structure width of 2.0m clear. Clear means between the closest parts of the barriers.
- > A clearly sign posted, well defined trail from beginning to end so visitors can easily find their way in both directions and during inclement weather
- > A compacted, well bound smooth riding surface with suitable camber to provide a pleasurable and easy riding experience. Riders should never feel they are going to slide off the trail. Minimum compacted aggregate depth of 75mm

- > All water courses to be culverted or bridged
- > Areas of significant fall hazard shall be protected with barriers that meet the building code. Areas of exposure where there is not a significant hazard may be protected with fencing, bunding, vegetation or signage
- > No stiles are to be used. All fences are to be crossed using cattle stops/bollards
- > A minimum of 10m clear sight distance is to be achieved around corners, or additional warning/speed calming measures may be required to avoid user conflict.

Grade 3



- > A minimum width of 1.2m but generally 1.5m wide allowing for comfortable single file riding only. The minimum width may be reduced to protect historic features, or for environmental or visual amenity reasons over short (50m) sections. Width caters for quad bike access for maintenance purposes.
- > Maximum prolonged gradient of 6 degrees (1: 10) for sections not longer than 100m with flat sections of minimum 25m length between. Maximum gradient of 9 degrees (1: 6) for no more than 30m without a flat recovery section of equal or greater length
- > Maximum out-slope cross fall of 3-6% for straight sections of track.
- > Corners shall have a minimum inner radius of 3m and in-slope gradient or cross-fall of minimum 8-15% (to be suited to the corner, speed and trail geometry) except hair pins which must not exceed Typical Detail Sheet R4030_E3_3 of 1.2m
- > Minimum structure width of 1.2m clear. Clear means between the closest parts of the barriers to ensure quad bike access.
- > A clearly sign posted, well defined trail from beginning to end so visitors can easily find their way in both directions and during inclement weather
- > A compacted riding surface of either insitu gravels or imported gravel to provide an all-weather surface. Minimum depths to suit ground conditions
- > Trail cross fall to provide an enjoyable riding experience for intermediate riders. Riders should never feel they are going to slide off the trail due to incorrect cross slope.
- > Water courses may be crossed with fords or be culverted or bridged if required. Any areas of soft or boggy ground shall be made all weather to prevent mud and damage to the trail surface
- > Areas of significant fall hazard shall be protected with barriers that meet the building code. Areas of exposure within 1m of the trail edge where there is not a significant fall hazard may be protected with fencing, bunding, vegetation or signage
- > Stiles may be used but preference should be given to using Cattle stops for convenience and maintenance purposes. Where a stile is used a gate is required adjoining for maintenance use.
- > A minimum of 5m clear sight distance is to be achieved around corners, or additional speed calming measures (trail alignment, sag, etc.) are required to avoid user conflict.

8 CYCLE TRAIL DESIGN CONSIDERATIONS

8.1 STEP 1: IDENTIFY THE USER GROUP & REQUIRED TRAIL GRADE

If the proposed trail is connecting communities and will form part of a larger network, then the minimum standard will be Grade 2 (Always design to achieve the best grade where possible).

The user groups for Grades 1 and 2 are as follows:

- a) Families including small children
- b) Novice riders who either have never ridden or ride infrequently
- c) Cycle tourers and commuters*
- d) Mountain bike riders
- e) Accessibility users

Groups (a) and (b) require a safe enjoyable cycling experience that is accessible with limited/no cycling skill. The trail must be designed with the needs of the most discerning user group in mind. For the above this would be families and novice riders. Cycle tourers, commuters and mountain bikers have a higher degree of skill and experience making them able to handle less well formed trails².

Having identified the user group, the designer should aim to achieve the flattest grade possible to meet the highest Grading. This ensures the maximum utility and accessibility to the community irrespective of other aspects of the design.

8.2 STEP 2: DESIGN ALIGNMENT

The designer needs to consider how to fit the trail into the land to minimise gradients, minimise hairpins, control storm runoff and drainage, climb hills, design and integrate structures and achieve the required width and finish that creates or results in a desire line.

8.3 DESIRE LINE

The designer needs to understand where the trail users are coming from (How do they access the trail) and going to (where will they leave the trail network) as well as how will the riders respond to the trail alignment in order to understand the desire line. Desire line refers to the preferred alignment for trail users and manifests itself in riders cutting corners or short cutting sections of trail they consider 'undesirable' when it has not been achieved.

An example of an error in desire line is making curves across a flat open section of terrain when a straighter piece of trail would suffice. Riders are likely to cut corners in this situation. Each section of trail should be considered from the rider's perspective to ensure that desire line is achieved as much as possible.

Ultimately desire line can be hard to predict. A designer needs to consider this especially in open country where riders can see the destination.

8.4 HAIR PINS OR SWITCHBACKS

It is often necessary to use hair pins (corners of ~180 degrees) to negotiate steep terrain. The use of hairpins needs very careful consideration to avoid rutting, erosion damage and safety issues for novice or inexperienced riders.

Hairpins should be graded such that the longitudinal grade through the corner is no more than 2 degrees with the cross-fall sloped to the inside to match the speed of travel such that the corner at the design speed feels safe and secure without sideways slipping.

² Commuter tracks require slightly different design considerations outside of the scope of this guide

Hairpin radius should be as wide as possible within the terrain constraints but not less than the minimum specified in design drawing R4030_E3_3 attached in Appendix 2.

The approach to a hairpin should provide enough sight distance for riders to slow down prior to the corner without locking their brakes and skidding. This requires that the approach gradient is quite flat (0-2 degrees) and the surface is well compacted. It is unacceptable to have a constant 4 degree grade into and through a hairpin as the approach will rut causing operational and maintenance issues. Designers may use a rolling-up grade dip (sag) to slow riders naturally prior to a corner. This reduces the likelihood of skidding and loss of control through the corner.

8.5 CURVES, HILLS AND CROSS-FALL

In hilly terrain, curves should follow the terrain. Additionally the terrain should be used to assist drainage with low points in gullies and higher points near ridges. This promotes drainage towards gullies.

The trail surface cross-fall should reflect the terrain and trail geometry. Out sloped corners (very dangerous) are to be avoided at all costs. When a corner is properly designed and built a rider feels well connected to the trail through adequate cross-fall for the design speed and side friction. Refer to the typical cross sections attached for guidance. There are no set rules, but the designer must ensure that the completed trail rides without inducing side slip or fear in the target user group.

8.6 GEOTECHNICAL ASSESSMENT OF TRAILS

At the initial scoping stage it is desirable to undertake a desktop assessment of available information to pin point any possible areas of instability where a trail is proposed. This allows appropriate planning and funding to be included at the design stage. Additionally the designer should walk the trail alignment to confirm no obvious areas of instability

During the design stage known areas of instability should be addressed by specific design or alignments. If avoidable, this is the preferred option. However, as most trails are built on public land adjoining water ways, often the only option is to build over these areas.

As part of the following approval process, areas of instability should be clearly identified on the design plans together with site assessment and solutions. Council wish to avoid ongoing maintenance issues relating to instability in cycle trails and it is hoped such planning will reduce the incidence.

8.7 DESIGN APPROVAL BY QLDC

Prior to any works commencing on the site, the trail designer shall submit the trail design plan, long section (if available – for large projects it is often not possible or cost effective to prepare detailed terrain models), typical cross section, trail design user group and outline of how the trail caters to the user group and fits the trail network together with construction specifications to QLDC for approval prior to commencing any trail works on site.

Additionally the designer shall ensure the proposed trail is marked out on site with flagging tape at no more than 20m intervals and staked in detail for hairpins and curves to ensure the proposed alignment is able to be assessed in detail. The assessment will include a minimum of alignment and gradient checks.

QLDC shall have the opportunity to inspect the trail alignment on site with the designer. Any amendments requested by the Council shall be addressed to Council's satisfaction prior to approval of the works.

While the approval process is designed to identify errors in the design and layout of the trail, it is not possible to anticipate every issue. Further, due to terrain constraints, vegetation cover and access, it may not be possible to assess and design every section of trail in a cost effective manner. Therefore, the design approval does not in itself reduce any liability on the trail developer to achieve the standards and riding requirements detailed in earlier sections of this standard.

8.8 TRAIL CONSTRUCTION & COMPLETION

At the completion of works, the trail contractor and developer shall certify the works as complete and issue a completion certificate in the form of NZS 4404:2010 Schedules 1B & 1C. The Council shall then inspect the works to confirm the completed trail meets the needs of the user groups/community the trail serves. This shall include test riding the completed trail, measuring grades and cross falls and corner radius. The completion inspection is not solely a compliance check but a confirmation of achieving the needs of the trail user.

Where the trail is found to be deficient in terms of grades, alignment, cross fall or other defects (see defects section), the

trail developer shall remedy the defect prior to Council signing the s224c certificate and/or taking over the trail asset. Alternatively the trail developer may enter into a cash bond for the value of the works in accordance with Council's bonding policy for land development works.

For trails involving structures that do not require a building consent the trail developer shall submit the following to Council:

- > NZS 4404:2010 Schedule 1B (contractors completion)
- > NZS 4404:2010 Schedule 1C certificate (Construction review)
- > Typical design details for the structure

Where a structure requires a building consent, the trail developer shall supply Council's Parks Department a copy of the building consent documents including PS1, PS3, PS4 and Code Compliance together with design drawings and/or as-built drawings prior to sign off/acceptance of the asset. While this may be a double up on the BC process, often the design detail is not readily accessible and the purpose is to ensure the Parks Department has a complete set of documents for ongoing operation and maintenance.

Additionally all trails and structures including bridges, culverts, signs, bollards, cattle stops, fences etc. shall be accurately surveyed and an as-built plan prepared and submitted in accordance with Council's land development standards to detail all trail related assets being taken over by Council.

8.9 THE DEFECTS PERIOD

Once the works have been signed off by Council as complete, the trail developer shall be responsible for a 12 month defects period. At the completion of the defects period, Council shall be advised and a final inspection undertaken. The final inspection shall assess the trail as if it were in the new as-built state. That is the trail developer shall be required to present the trail in an as-new condition at the end of the defects period.

If the trail requires changes to alignment to avoid or remedy rutting, surface erosion or desire line errors, the trail developer shall be responsible for such modifications at their cost prior to Council taking over responsibility irrespective of whether these were noted at the time of the design approval or completion inspection as often it takes time for errors in design and construction to manifest through use of the trail.

The following parameters shall be achieved for completed trails at the end of the defects period:

- > The trail shall have good flow and speed control that does not result in rutting or surface erosion from skidding
- > Finished surface shall be interlocking at the end of the defects period and free from loose gravel.
- > The surface of the gravel and +0.5m either side of the formation edge shall be clear of all weeds. If there are weeds within the surface gravel, this shall be considered a defect and the developer shall be liable to remedy by mechanical removal.
- > Within all the earthworked areas adjoining the trail, all noxious weeds shall be removed
- > All verges shall be mown/cut to a maximum 350mm height up to +0.5m off the edge of the formation
- > Any stormwater erosion shall be stabilised with rock protection or matting
- > Adverse cross fall shall be rectified
- > Any silting of culverts or debris in culverts or water tables shall be cleared
- > Full design width shall be presented
- > Vegetation shall be clear 1.0m beyond the edge of the trail and 2.5m above the trail

9 TRAIL CONSTRUCTION SPECIFICATION – GRADE 2

Attached as Appendix 1 is the standard Construction Specification for a Grade 2 Trail. The specification outlines the standard work methodologies required to complete a cycle trail to Council standards.

Where designers are forming a Grade 1 or Grade 3 trail, the specification shall be modified in accordance with the section “Detailed Trail Grade Specifications” to take account of differing maximum gradients, curve radius, surface and so forth.

10 TRAIL CONSTRUCTION – TYPICAL CROSS SECTIONS & DETAILS

Attached as Appendix 2 are typical cross section and detail plans ref R4030_E3_1-4. These provide design detail in relation to typical cross sections in different terrain, use of curves and hairpins and other typical details used in cycle trail construction but are not intended to cover every aspect of trail construction.

11 REFERENCES

- > International Mountain Bicycling Association (IMBA) “Guide to Building Sweet Single Track”
- > Standards New Zealand NZS HB 8630:2004 – Tracks and Outdoor Visitor Structures
- > “Cycle Trail Design Guide” 2010 Viastrada/MED, prepared for the New Zealand Cycle Trail Project
- > QLDC Cycleway Maintenance Specifications c.2010
- > Standards New Zealand NZS 4404:2004 – Land Development & Subdivision Engineering
- > “Track Construction & Maintenance Guidelines” 2006, Department of Conservation

APPENDIX 1 – CONSTRUCTION SPECIFICATIONS



GRADE 2 - CYCLE TRAIL CONSTRUCTION

Technical Specification

Overarching Requirements

Trail Construction must be compliant with QLDC District Plan requirements for example Earthworks, and have the appropriate Consents, be that Building Consent or Resource Consent. It is the Developer and Project Managers responsibility to ensure that the construction is compliant in this regard.

1. TRACK CONSTRUCTION

1.1. Track Alignment

- 1.1.1. The track alignment is marked on site with RED/WHITE flagging tape. Markers are generally spaced at 20-50m intervals.
- 1.1.2. The Contractor is responsible for setting out and constructing the track following these markers.
- 1.1.3. If the Contractor wishes to deviate the track formation more than two meters either side of the design line, specific approval shall be obtained from the Engineer for every deviation.
- 1.1.4. Deviation from the design line up to two meters either side may be made to avoid living trees, archaeological features, fallen logs, rocks or adverse ground conditions. Approval from the Engineer is not required in such instance.
- 1.1.5. The Contractor shall be responsible for ensuring the maximum track gradient requirements in this specification are not exceeded on the track. If the Contractor believes this cannot be achieved on the design line or within two meters of this then he shall advise the Engineer.
- 1.1.6. The constructed formation shall follow the most practical line to achieve the design grades and to create an enjoyable riding experience appropriate to a Grade 2 trail (See QLDC Cycle Trail Design Standards 2015).

1.2. Formation Earthworks, Width & Grade

- 1.2.1. During construction compliance with the QLDC Land Development and Subdivision Code of Practice is a requirement, attention is drawn to the following key points;
- During construction sediment control measures should be put in place such as keeping drains clear of loose soil and the use of silt fences, traps or bunds around water bodies. Efforts to revegetate battered slopes and cleared land should be made as soon as possible. Long term options include draining to sediment retention ponds where high levels of sediment run off are expected
 - Dust mitigation should be used during construction or on any maintenance areas left exposed for extended periods of time. Mitigation includes wetting ground and long term; use of vegetation on bare land
 - Earthworks undertaken must be stable and not prone to erosion
- 1.2.2. All organic material shall be removed from the track formation area prior to commencing any formation earthworks. Where possible, leaf litter and top soil shall be retained adjacent to the track for spreading over exposed earthworks on completion of the formation.
- 1.2.3. Tree roots up to 100mm diameter shall be removed where necessary to enable formation excavation.
- 1.2.4. Where the track is constructed on a cross slope of less than 3 horizontal to 1 vertical, the track bench may be constructed using a combination of cut and fill formation or fill formation as shown on the drawings. Excavated material from the formation may be used to fill the outer edge of the track bench provided it is compacted in place with suitable equipment.
- 1.2.5. Where the track is constructed on a cross slope of greater than 3 horizontal to 1 vertical, a full cut formation (full bench) detail shall be used as shown on the typical detail. Cut slope batters may be constructed with a max height of 2m with a 1m horizontal bench if higher slope is required. Slope angles (H:V) of 2.5:1 for silt, 2:1 for sand and, 1.5:1 for gravels can be used. Vertical faces can be used for intact rock only, consult Engineer for non-intact rock faces otherwise revert to 1.5:1 specification.
- 1.2.6. The track formation shall be shaped to achieve the required track width and to ensure the track longitudinal grade is within the required maximum limits. The maximum grade on any section of track shall not exceed the following:
- 1 in 14 (4°) on regular sections of track for lengths less than 100m, otherwise 10m flat sections are to be placed every 50-75m. Short 30m sections of 1 in 10 (6°) may also be used in conjunction with at least equal length of flatter sections.
 - 1 in 30 (2°) on switchbacks and structures
 - Or as directed by the Engineer
- 1.2.7. The required 'usable cycling surface' width shall be 2.0m unless otherwise specified by the Engineer. This shall consider horizontal clearances required from cut/fill batter slopes, handrails (0.5m), trees (0.5m) etc. as detailed in Section 3.5 of NZCT Cycle Trail Design Guide Feb 2010.
- 1.2.8. Final shaping of the track surface shall take place **after** the installation of culverts.

1.3. Filling

- 1.3.1. There should be no vegetation or other organic matter in fill material that forms part of the track formation.
- 1.3.2. Fill material shall be placed in layers not exceeding 300mm loose depth and shall be compacted using appropriate mechanical equipment. Where the slope exceeds 3 horizontal

to 1 vertical a bench shall be formed to enable fill material to key into the existing ground and facilitate compaction.

- 1.3.3. Fill material shall not be used where the moisture content is at or above the plastic limit as densification cannot be achieved. Such material shall be placed outside the track formation.
- 1.3.4. Fill materials should have an even grading with no segregation, the image below is an example of a non-complying material



- 1.3.5. Fill slopes shall be left in a smooth and tidy condition. It shall be the contractor's responsibility to make good any batter slumping or subsidence which occurs during the operation of this contract and including during the defects liability period.
- 1.3.6. Where fill is intended to be placed onto soft or swampy ground, the Engineer may advise the Contractor to lay geotextile material to separate the fill material. Geotextile shall be laid in accordance with manufacturers recommendations.

1.4. Track Drainage

- 1.4.1. Rolling grade dips (grade reversals) shall be formed in the track surface to divert surface water on sloping sections of track at
- 1.4.2. $\leq 30\text{m}$ spacing's where water tables are not installed. Grade reversals shall be 2-3m in length and be of a smooth profile to ensure a smooth ride for cyclists.
- 1.4.3. Water tables in accordance with the typical details shall be installed on each section of track formation prior to placing top course metal.
- 1.4.4. Water tables shall have a grade of $>1\%$ towards the discharge point (if any). A discharge point shall be provided anywhere there is a sag point in the track.

- 1.4.5. Water table discharge points shall be installed at the following spacing's or as directed by the Engineer:
- 1.4.6. 50m where the track grade is $\leq 20:1$ (3°)
- 1.4.7. 15m where the track grade is between $10:1$ and $20:1$ (3° - 6°)
- 1.4.8. Water table discharge shall consist of minimum 250mm smooth walled culvert under the track to direct water to lower ground on the down slope side of the track.
- 1.4.9. Culvert pipes shall be installed with a minimum 5% fall to the outlet and a minimum of 150mm cover to the finished track surface.
- 1.4.10. The inlet to culverts installed for the discharge of water tables shall have a 200mm x 200mm x 250mm minimum deep sump at the culvert inlet which has an invert level at least 100mm below the culvert pipe invert. A 300mm long stop bank shall be provided after the sump pit to force water into the pipe.
- 1.4.11. Culverts shall be of sufficient length to pass under the track and extend beyond any fill.
- 1.4.12. The outlets of culvert pipes shall discharge at ground level without a free fall from the end of the pipe. Where the outlet slope is on steep loose material, a rock apron shall be provided to prevent scour.
- 1.4.13. Culverts shall be smooth bore Farm Tough type colored black of minimum 250mm internal diameter or similar as approved by the Engineer.
- 1.4.14. The inlet and outlet of culverts that discharge continuous water flows shall include local stone/mortar headwalls.
- 1.4.15. Where the culvert discharges only stormwater and the inlet or outlet may be subject to maintenance vehicle loads (that is they are within 300mm of the track edge), the headwalls shall be mortared.
- 1.4.16. For all other culverts where the inlets and outlets are not able to be driven on, headwalls are optional
- 1.4.17. Lintel rocks for headwalls shall have a minimum diameter (or long side) of not less than 2x culvert diameter for pipe sizes 250- 500mm diameter.

1.5. Track Shaping

- 1.5.1. Prior to placement of track surfacing aggregate, the track sub- grade shall be shaped as follows
 - Crowned surface having a **maximum 3%** fall to each side from the centerline for straight sections in flat country.
 - Single slope formation with a 3% fall to the downhill side for straight sections in hilly country or where side drains are not provided.
 - Single cross slope formation with a **5-10% fall to the inside of corners** for winding sections.
 - If after rain, water is left sitting or pooling on the surface at more than 20mm depth, this will be considered a defect and require rectification by the contractor.

1.6. Pavement Surfacing

- 1.6.1. Prior to placement of track surfacing, the strength and density of the track sub-grade shall, wherever possible, be improved by the use of suitable compaction equipment such as vibrating rollers or plate compactors.
- 1.6.2. Suitable surfacing material shall be a crushed & well graded AP20 (or smaller) type aggregate having a maximum particle size of 20mm and be supplied from a weed free source. The stone particles shall be durable with at least 50% crushed faces. Rounded particle river gravels or beach gravels are not acceptable as a track surfacing aggregate.
- 1.6.3. Ideally the track surfacing aggregate shall have a range of particle size distribution including between 5-8% by weight portion of clay content to facilitate binding the surface.
- 1.6.4. A sample of aggregate shall be provided to the Engineer for approval prior to placement.
- 1.6.5. The track surface layer shall have a minimum compacted depth of 75mm minimum (equates to 100mm loose). This layer shall be placed and compacted in a single layer or where additional material is added after compaction the original layer shall be scarified prior to placement of the additional aggregate.



- 1.6.6. A 5-10mm layer of crusher dust shall be used to cap the aggregate layer and provide a smooth riding surface.



- 1.6.7. The aggregate shall be placed in such a way as to minimize segregation of the particle sizes. Shovels, beam rakes or excavator buckets should be used to move material if required.
- 1.6.8. The surface shall be shaped to achieve the required cross fall and longitudinal smoothness with a grader or similar machine. Grading with an excavator is not acceptable.
- 1.6.9. The aggregate surface shall be compacted after placement with a plate compactor or other vibrating equipment to achieve a well bound surface suitable for cycling. The cross fall of the finished track surface shall be as stated in Section 4.5.1.



- 1.6.10. To achieve optimum compaction, water shall be sprayed onto the aggregate surface. Compaction will be deemed complete when a well bound pavement surface is achieved which is free of voids and loose stone.



- 1.6.11. The completed track surface shall be free from loose stones (interlocking mosaic is required) and **surface undulations** to achieve a smooth & comfortable riding experience. Wavy or corrugated surfaces shall be deemed a defect and shall not be acceptable. The final test shall consist of riding a standard non- suspended bicycle along the completed surface to check for such defects. A clegg value of 27 is required on the finished surface (prior to crusher dust application)

1.7. Rock Excavation & Blasting

- 1.7.1. Areas requiring rock excavation are not necessarily shown on the design drawings.

- 1.7.2. Blasting of rock may be used where it is not practical to break or remove rock by mechanical means and achieve a solid level surface finish for the formation.
- 1.7.3. Any rocks that are too large to move whole shall be drilled and blasted.
- 1.7.4. All blasting shall be carried out in accordance with the Department of Labor Code of Practice for Construction Blasting Safety.
- 1.7.5. The Contractor shall provide the Engineer with at least **48 hours' notice before blasting operations are to commence**. The Ministry of Business Innovation & Enterprise shall be notified at least 24 hours prior to the blasting commencing.

2. HERITAGE & ENVIRONMENT

2.1. Archaeological Matters

- 2.1.1. If any archaeological evidence in the form of mining relics, stacked stone tailings, water races, sluicing, shell, bone, charcoal, greenstone, hangi stone, or artefact is uncovered during any construction, work must cease in that particular area and the Engineer must be notified immediately.
- 2.1.2. Work in the vicinity of sites where archaeological evidence is uncovered shall not re-commence until the Engineer gives approval. Delays due to unexpected finds may be a variation at the applicable rates.
- 2.1.3. The contractor shall implement all mitigation measures approved in any archaeological authority obtained from the Historic Places Trust relating to track works. If this is not practical, they shall advise the Engineer prior to any works covered by such Authority.

2.2. Vegetation

- 2.2.1. The survey line/design plans marked will identify all vegetation requiring removal. Mature trees will be affected in some areas due to legal access constraints but in general the track alignment should consider options around mature trees and any significant fauna. Endeavor to minimize destruction of native flora and promote growth of native species over non-native species.
- 2.2.2. Any tree exceeding 300mm diameter, that needs removal will be identified prior to the start of any works; any tree exceeding 300mm diameter must have the approval of the Engineer before it can be removed.
- 2.2.3. The completed track must have a cleared vegetation line of 2.5m vertical and a horizontal line of 1.0m either side of the track edge. All stumps created in the course of the construction are to be removed from track area unless indicated by the engineer. All slash, branches and removed stumps must be removed from site or chipped or burned (note burning requires a permit from the TA).
- 2.2.4. If a tree has to be retained details are to be supplied to protect the roots of trees \
- 2.2.5. Will ensure that disturbance to any trees & roots systems is minimised during construction or done in arboriculturally sensitive manner that is within the tolerances of the tree(s).

2.3. Sediment & Dust Control

- 2.3.1. Silt fences, traps or bunds should be used around water bodies. and cleared regularly to maintain functionality. Efforts to revegetate battered slopes and cleared land should be made as soon as possible. Where high levels of sediment run off is expected retention ponds may be deemed appropriated.
- 2.3.2. Dust shall be mitigated during construction and maintenance activities through wetting of

bare soil, covering stockpiles or revegetation.



2.4. Health & Safety

- 2.4.1. The Contractor shall at all times comply with the provisions of the Health and Safety in Employment Act 1992. The Contractor shall take all necessary steps to ensure that the obligations placed on the “Principal” and the “Person who controls the place of work” under the provisions of the Act are complied with at all times and shall immediately advise the Principal of any obligations not being fulfilled.
- 2.4.2. The Contractor shall prepare a Safety Plan, which shall identify all potential risks and hazards to all personnel on site. The plan shall include safety procedures, requirements for protective clothing and equipment, safety equipment, mitigation procedures, emergency procedures, emergency communications and any other requirements deemed necessary.
- 2.4.3. The Safety Plan shall be submitted to the Engineer by the Contractor who shall confirm that the Safety Plan has been implemented and is operating on the site.
- 2.4.4. If at any stage during the course of the works, the Engineer or the delegated representative(s) observe activities or procedures which do not comply with the Safety Plan, a ‘Stop Work’ notice may be issued to the Contractor.
- 2.4.5. Extensions of time arising out of ‘Stop Work’ notices issued to the Contractor due to non-compliance with the Safety Plan will not be considered.
- 2.4.6. The Contractor shall ensure that during the execution of the Contract there is no risk to the health and safety of other Contractors or employees of DOC, LINZ or Contact Energy, or to members of the public that may be in the vicinity of the site.
- 2.4.7. The Contractors’ Safety Plan shall include particular procedures with respect to maintaining the safety of users of the track during construction including use of appropriate signage, barriers and other protection deemed necessary.
- 2.4.8. The contractor shall use all practical means to prevent members of the public from using any structures until such time as a Code of Compliance Certificate has been issued for the structure.

2.5. Building Consent

- 2.5.1. The Contractor shall comply with all conditions of Building Consents relating to structures.
- 2.5.2. If inspections are required by the Council building inspectors, it shall be the Contractor's responsibility to ensure that the Council is kept informed and given sufficient notice as to when inspections are needed.
- 2.5.3. The Principal shall obtain all building consents unless otherwise noted.

2.6. Resource Consent

- 2.6.1. The Contractor shall comply with all conditions of Resource Consents relating to track formation and structures.
- 2.6.2. If inspections or monitoring is required by either the QLDC or ORC it shall be the Contractor's responsibility to ensure that the Council is kept informed and given sufficient notice as to when inspections are needed.

2.7. Producer Statements

- 2.7.1. The Contractor shall, on completion of the works, provide the Engineer with a Producer Statement-Construction (PS3) as setout in NZS 3910:2003 Schedule 6. The issuing of a Certificate of Practical Completion is subject to the receipt of the PS3.

2.8. Reinstatement of Area & Grassing

- 2.8.1. The Contractor and any Sub-constructors employed by the Contractor shall reinstate all land affected by the works, including the re-establishment of working areas, to a condition at least equal to that at the commencement of the works. Grass seed shall be spread on all areas of spoil where appropriate. All fencing disturbed shall be reinstated with new fencing of the same style as what was removed

2.9. Materials brought onto Site

- 2.9.1. All aggregate brought onto the site for the purpose of track surfacing or any materials brought in as fill, are to be from a weed free source and are to be inspected and approved by the Engineer prior to delivery on site.
- 2.9.2. Materials are to be stockpiled in approved places and all remnants removed from the site on the completion of the project, except where the Engineer has approved surplus materials that may be left in stockpiles on the site.

2.10. Removal of Waste Material

- 2.10.1. All timber cut-offs, surplus materials and any waste is to be removed from the site at the completion of the work
- 2.10.2. Waste is defined as all foreign material on the site. This includes but is not limited to spilt concrete, nails, wood, plastic and metal off-cuts.
- 2.10.3. Waste or rubbish being held at the site prior to removal is to be stored in such a fashion that it cannot be blown about by the wind. No tyres are permitted.
- 2.10.4. Major repairs to machines are not permitted on site without approval of the Engineer.

2.11. Helicopter Operations

- 2.11.1. The Contractor shall obtain prior approval from the Engineer before each and every helicopter operation.
- 2.11.2. The Contractor is responsible for obtaining all required Civil Aviation and other permits

necessary for helicopter operations.

- 2.11.3. The Contractors Safety Plan shall include procedures for such operations and the proposed measures to ensure public safety during the operations.
- 2.11.4. All materials dropped by a helicopter operator either by accident or on purpose outside of approved sites must be reported to the Engineer as soon as possible and any such materials shall be removed as soon as possible. Site restoration work must be carried out to the satisfaction of the Engineer in the event of any damage from dropped items.

3. TIMBER STRUCTURES

3.1. Relevant Standards

- 3.1.1. The underlying Standards relevant to this Section are:

NZS 3601	Metric Dimensions of Timber
NZS 3602	Timber & Wood Based Products for use in Buildings
NZS 3603	Timber Structures
NZS 3604	Light Timber Framed Buildings
NZS 3605	Timber Piles & Poles for use in Buildings
NZS 3640	Timber Treatment Specifications
NZS 1328	Glue Laminated Structural Timber
NZS HB 8630	Tracks and Outdoor Visitor Structures

3.2. Scope & General

- 3.2.1. This section of the contract work shall consist of all carpentry including the associated jointing brackets, cleats, bolts, nails etc. as shown on the drawings or specified herein or otherwise.
- 3.2.2. This includes, but is not exclusive to the construction of boardwalks, barriers and retaining walls.
- 3.2.3. **All timber shall be sound, free from knots** and well-seasoned and maintain figured dimensions.
- 3.2.4. All timber shall be rough sawn sizes unless specifically noted otherwise.
- 3.2.5. Timber shall comply with Table 1

3.3. Timber Treatment

- 3.3.1. Treatment shall be as noted in the table below. Treatment shall comply with the current requirements of the Timber Preservation Council. All treated timber shall be branded with the appropriate woodmark. It is preferred that timbers be treated at least 2 months prior to installation.
- 3.3.2. Cut faces of timber sections greater than 50mm thick shall be treated with Metalex or similar field applied preservative treatment.

Table 1: Timber Specification and Treatment

Structure & Application	Species	Grade	Treatment
Round piles	Pinus Radiata.	NZS 3605	H5
Retaining wall boards, Boardwalk end boards and bearers and other sawn timber in contact with the ground or within 150mm of the ground.	Pinus Radiata	G8 or VSG8	H5
Boardwalk joists, bracing, decking and blocking. Barrier balusters and rails	Pinus Radiata	G8 or VSG8	H3.2
Glulam Beams	Pinus Radiata	GL10	H3.2

3.4. Fixtures & Fittings

- 3.4.1. Bolts and washers shall be hot dip galvanised engineer's bolts of the diameters and sizes shown on the drawings unless specified otherwise.
- 3.4.2. Bolts may consist of hot dip galvanised or stainless steel threaded rod cut to length on site.
- 3.4.3. All hot dip galvanised rod cut ends shall be treated with 'dry galv' corrosion protection.
- 3.4.4. All galvanised bolts in contact with treated timber shall be protected using general purpose grease in pre-greased holes
- 3.4.5. Thread protrusion past the nut shall be a minimum of one thread pitch after tightening.
- 3.4.6. All nails shall be 100mm x 4.0mm FH galvanised steel unless specified otherwise.
- 3.4.7. The contact faces of washers shall be coated with grease.
- 3.4.8. Washers shall be fitted to both ends of bolts and shall comply with the following minimum standards:

Bolt Size	Washer (mm)
M12	50 x 50 x 5.0
M16	65 x 65 x 5.0

3.5. Protection Up to Installation

- 3.5.1. All materials shall be protected against physical damage.

3.6. Standards of Workmanship

- 3.6.1. All work shall be in accordance with industry best practice
- 3.6.2. Details not shown on the drawings shall be formed according to the principles of NZS 3604 or referred to the Engineer.
- 3.6.3. All work is to be accurately set out.
- 3.6.4. All structural members are to be fixed true to line.

3.7. Foundations & Concrete Work

- 3.7.1. All Concrete used for the embedment of posts or headwalls shall have a 20mm maximum aggregate size and be a mix designed to have a minimum 28-day compressive strength of 20MPa.
- 3.7.2. All concrete shall comply with NZS 3104 or NZS 3108 including specification and techniques setout herein.

- 3.7.3. The contractor shall be responsible for locating any services on site. Any damage to underground services shall be repaired at the Contractors expense.
- 3.7.4. Excavations for foundations are to be built to the dimensions and details shown allowing for working room as required.
- 3.7.5. Where holes are dug or augured for foundations, the Contractor is responsible for ensuring the stability of the hole to ensure the hole maintains its required dimensions before pouring concrete. The costs of any stability work will be deemed to be included in the Contractors tender price.

3.8. Glue Laminated Structural Members

- 3.8.1. All beams shall comply with NZS 1328 GL10 grade.
- 3.8.2. Material for the members shall be Radiata Pine with a moisture content not exceeding 18%.
- 3.8.3. All members shall be made for Category 3: Exterior Exposed. The adhesive used shall be resorcinol glue.
- 3.8.4. End joints should be randomly spaced throughout the depth of a member to avoid concentration of joints.
- 3.8.5. Finish shall be 'standard' in accordance with NZS 3606 unless specified otherwise.

4. GABION PROTECTION

4.1. Installation

- 4.1.1. Gabion baskets unless otherwise specified shall be 2m long by 1m high and 1m wide and made from 2.7mm pvc coated wire.
- 4.1.2. Gabion baskets shall be installed in accordance with the manufacturers recommendations and industry best practice including appropriate backfill, inter-connections and tying and geotextile separation (filter cloth) to prevent backfill migration.
- 4.1.3. All areas requiring gabion wall installation shall be marked on site by the Engineer prior to installation and agreed with the contractor.
- 4.1.4. Where gabions are laid more than 1m in height, subsequent layers shall be offset 300mm.

5. TIMBER RETAINING WALLS

5.1. Installation

- 5.1.1. Timber retaining walls shall be installed in accordance with the design drawings to achieve minimum embedment depths, maximum heights and angles.
- 5.1.2. All timber retaining walls shall be fixed together with either galvanized bolts/washers or galvanized purlin screws. Nails shall not be used for fixing timbers.
- 5.1.3. All timbers shall comply with Section 3.3 Table 1 above.

6. TIMBER CRIB WALLS

6.1. Installation

- 6.1.1. Crib walls shall be installed in accordance with the design drawings
- 6.1.2. All timber shall comply with Section 3.3 Table 1 above

- 6.1.3. Timber shall not be joined with nails. All timbers shall be either plated and bolted or plated and galv purlin screwed together to prevent breakage and splitting of timber.
- 6.1.4. The end and corners of such walls are to be protected with a minimum 100x50 timber running vertically to prevent end breakage

7. CATTLE STOPS & BOLLARDS

7.1. Design & Installation

- 7.1.1. Cattle stops shall generally be as per the typical detail plan Sheet R4030_E3_4 The cattle stops shall have a minimum trafficable width as per the required minimum structure width for the trail Grade to enable maintenance access
- 7.1.2. Cattle stops shall have as a minimum a galvanized steel grate consisting of either rounds or flats sharp side up welded to a steel surround. Base and sides may be either timber or metal.
- 7.1.3. Cattle stops shall be installed at grade with the adjoining cycle trail and in line. Where restricting vehicle access is necessary, a timber bollard shall be installed in the center of one approach and be of the lockable type.
- 7.1.4. A minimum 100mm flexible pipe shall be installed into the base of the cattle stop to enable hedgehogs to exit from the sump
- 7.1.5. Bollards for use on QLDC trails shall be as per attached typical detail plan XXXXX and shall be installed in accordance with this plan. Bollards can be Macrocarpa but must be treated at ground level and below, frangible and capped on the top surface.

APPENDIX 2 – TYPICAL DESIGN DETAILS

